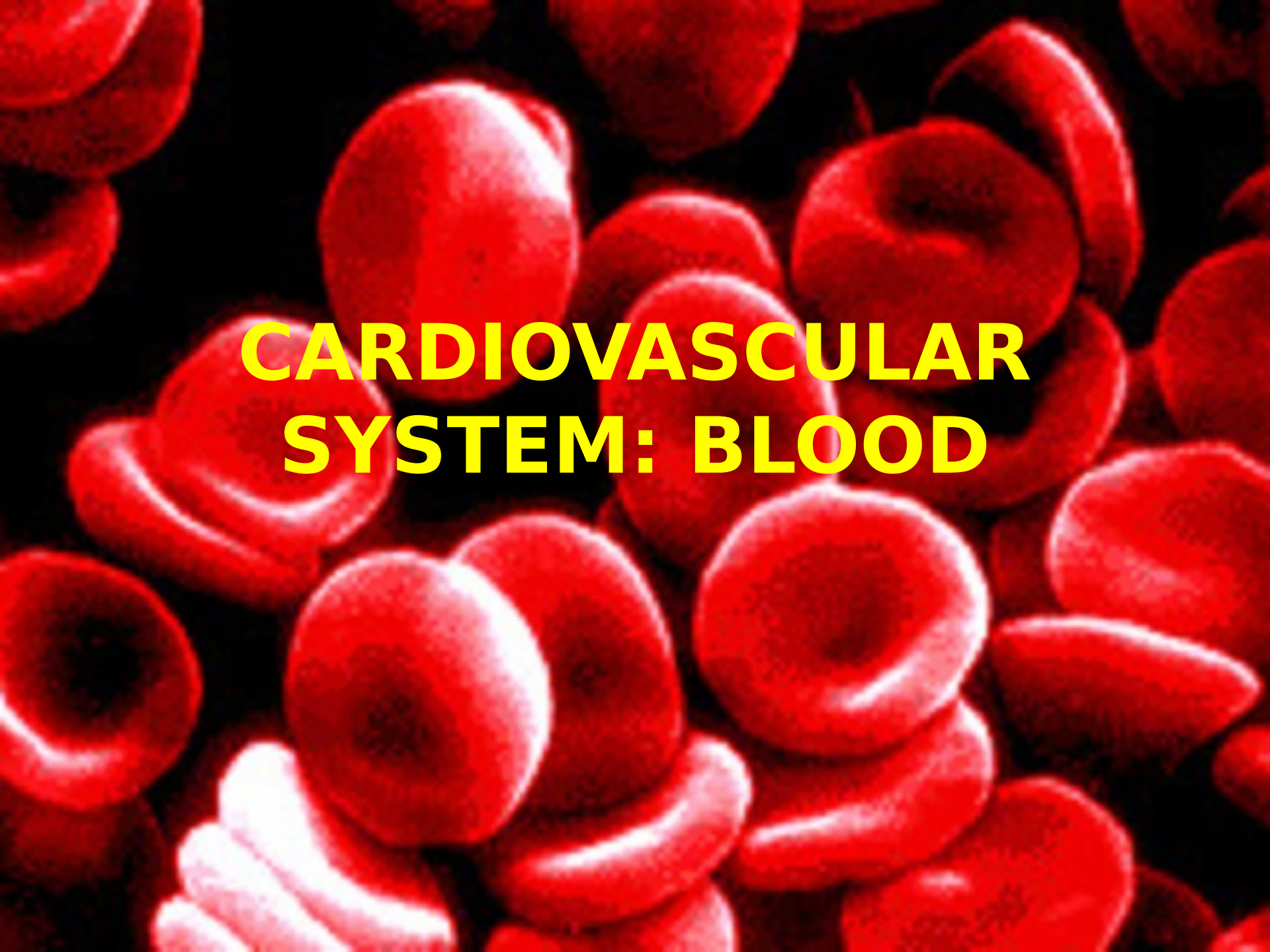
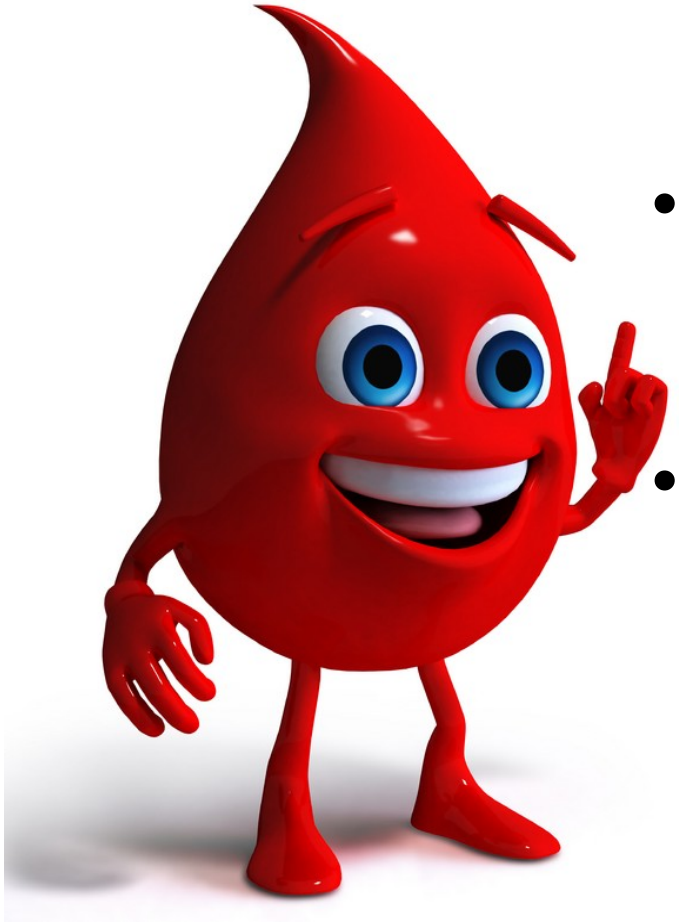

CARDIOVASCULAR
SYSTEM: BLOOD

Physical Characteristics of Blood

- it is denser and more viscous than water
- slightly sticky
- the temperature of blood is **38°C (100.4°F)**
- a slightly alkaline pH ranging from **7.35 to 7.45**

Physical Characteristics of Blood



- it constitutes about 20% of extracellular fluid
- it amounts to 8% of the total body mass

Physical Characteristics of Blood

- blood volume is **5 to 6 liters (1.5 gal)** in an average-sized adult male
- **4 to 5 liters (1.2 gal)** in an average-sized adult female

Components of Blood

Blood Plasma

55%

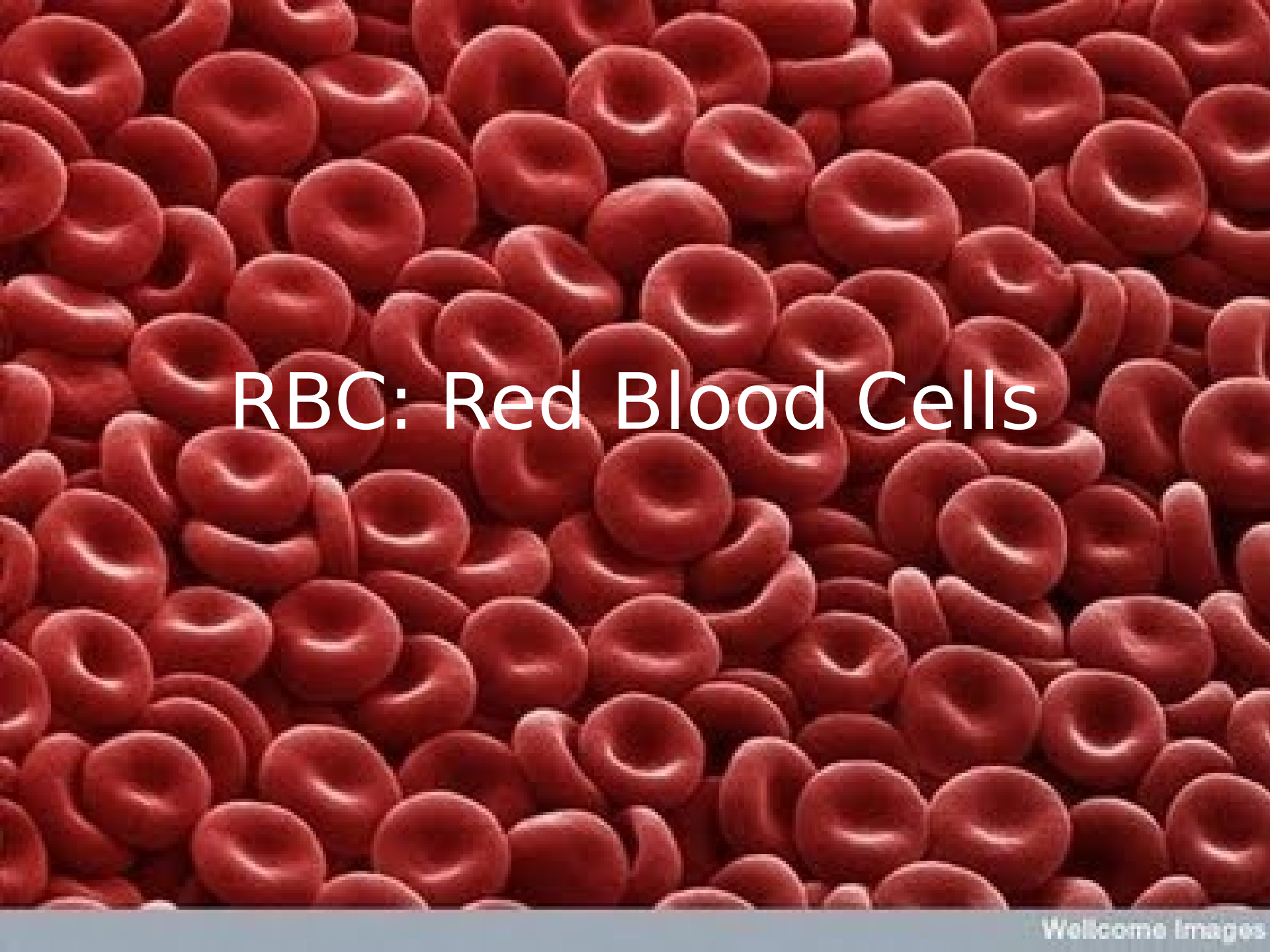
- water (91.5%)
- proteins (7 %)
- solutes (1.5%)

PROTEINS: 7%

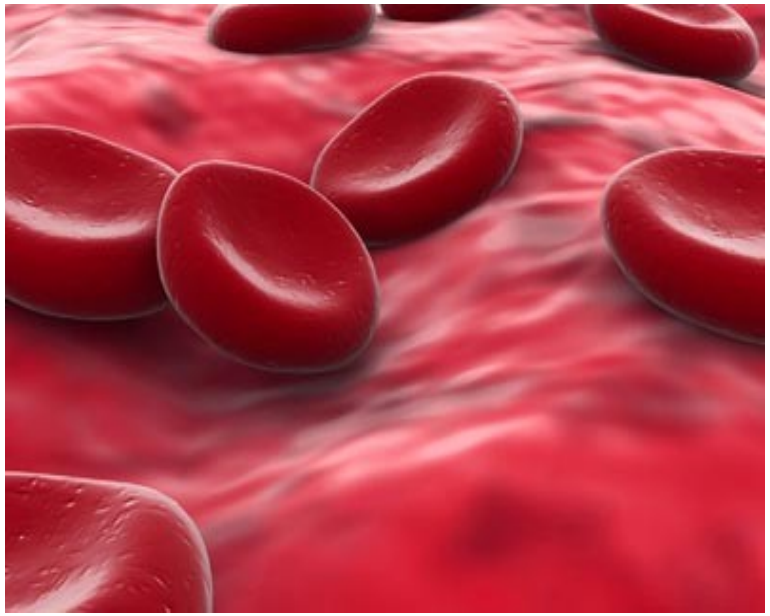
- Albumins 54%
- Globulins 38%
- Fibrinogen 7%
- others 1%

OTHER SOLUTES

- Electrolytes
- Nutrients
- Gases
- Regulatory substances
- Waste products

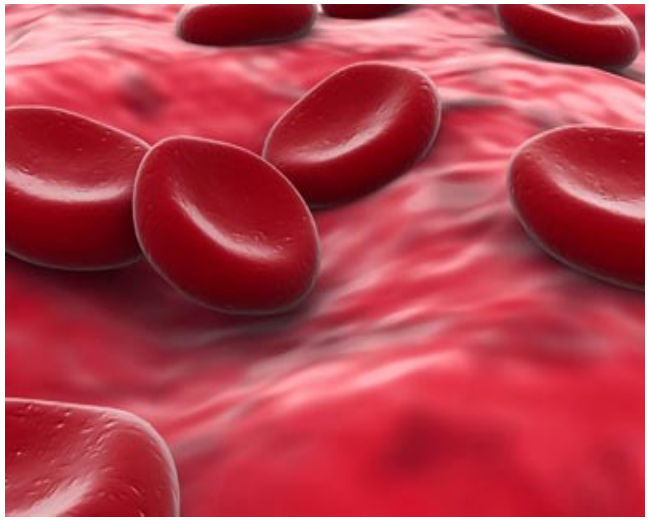

RBC: Red Blood Cells
Wellcome Images

RED BLOOD CELLS (RBC)



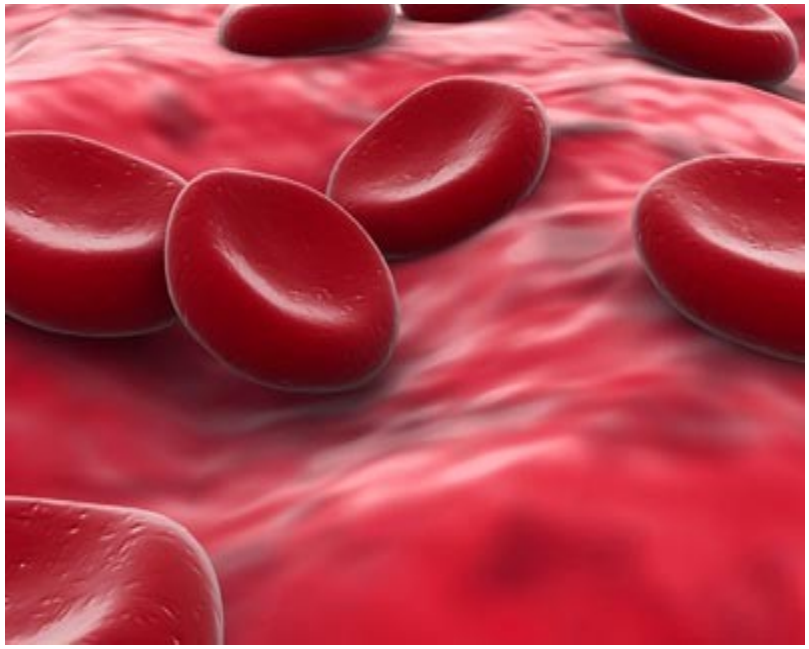
- Erythrocytes
- 4.8-5.4 million/µl of blood
- hemoglobin
  - oxygen-carrying protein
  - a pigment that gives whole blood its red color

RED BLOOD CELLS (RBC)



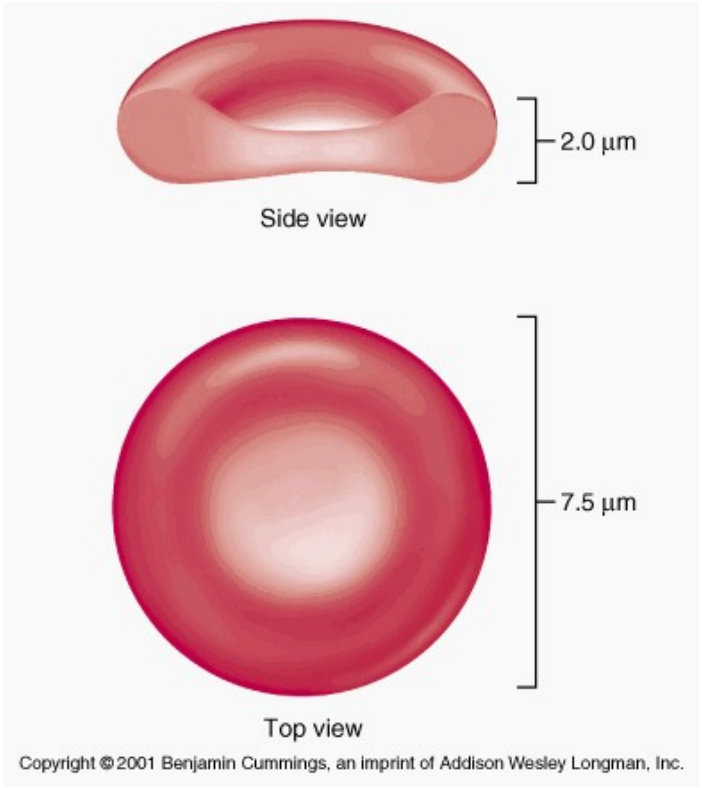
- 5.4 million red blood cells/µl of blood (healthy adult male)
- 4.8 million/µl of blood (healthy adult female)
- one drop of blood is about 50µl

red blood cells (RBC)



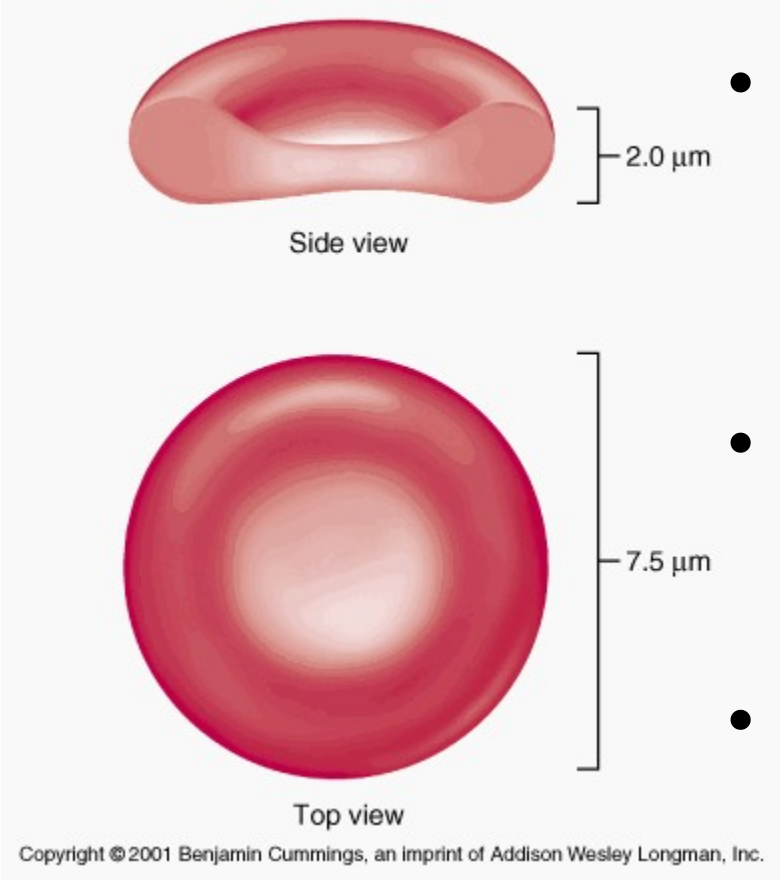
- 2 million cells /sec.
  - number of new mature cells that must enter the circulation to maintain the normal number of RBCs
  - it is a pace that balances the

RED BLOOD CELLS (RBC): ANATOMY



- biconcave discs
- diameter of 7–8 µm
- plasma membrane is both strong and flexible
  - allows them to deform without rupturing as they squeeze through narrow capillaries

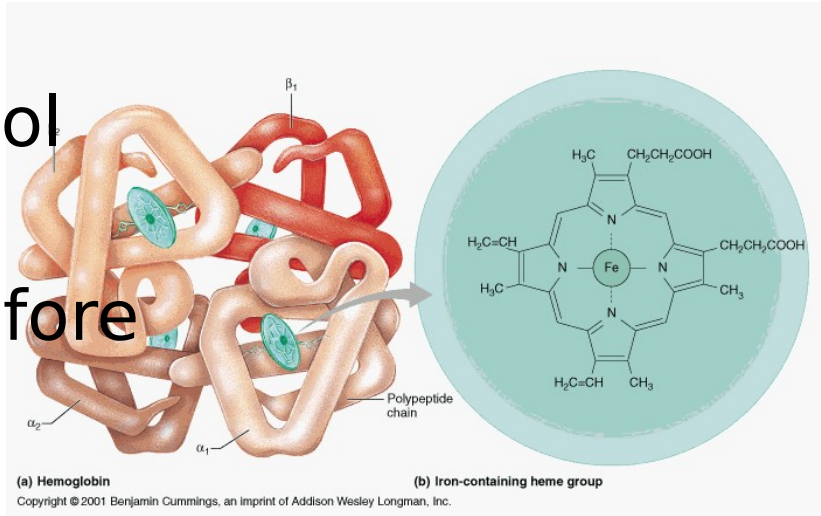
RED BLOOD CELLS (RBC): ANATOMY



- glycolipids act as antigens that account blood groups (ABO) and Rh groups
- lack a nucleus and other organelles
- neither reproduce nor carry on extensive metabolic activities

HEMOGLOBIN

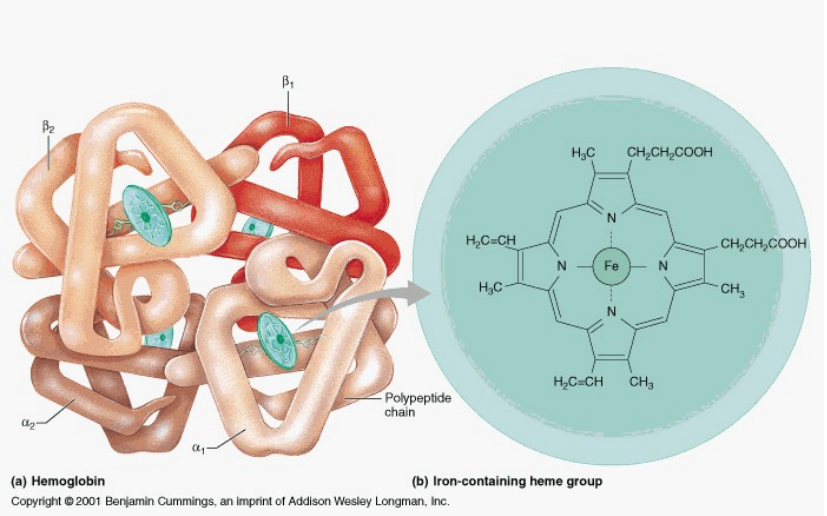
- located within the cytosol
- they are synthesized before loss of the nucleus



- constitute about 33% of the cell's weight
- 280 million in each RBC

HEMOGLOBIN

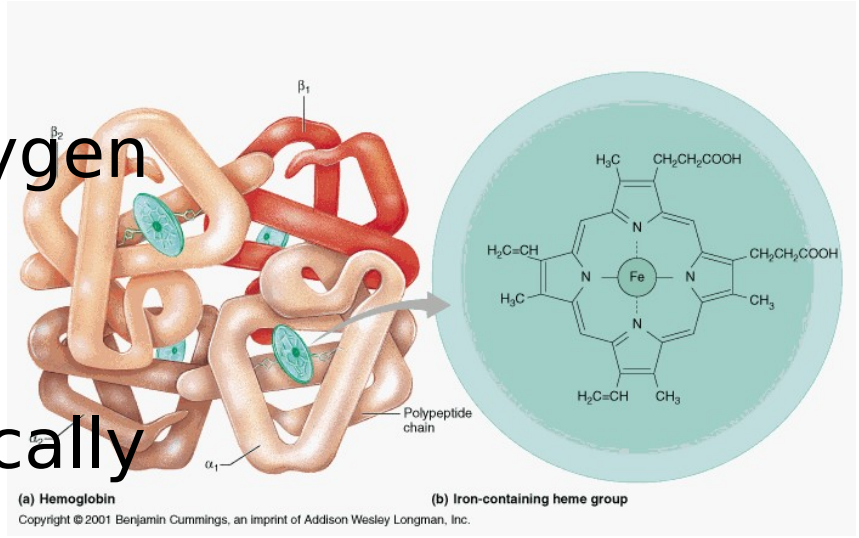
- GLOBIN
  - protein part
  - composed of four polypeptide chains
    - 2 α-chains
    - 2 β- chains



- HEME
  - a ringlike nonprotein pigment
  - four units bounded to four polypeptide chains
  - at the center is an Iron ion (Fe^{2+}) that can combine with one oxygen molecule

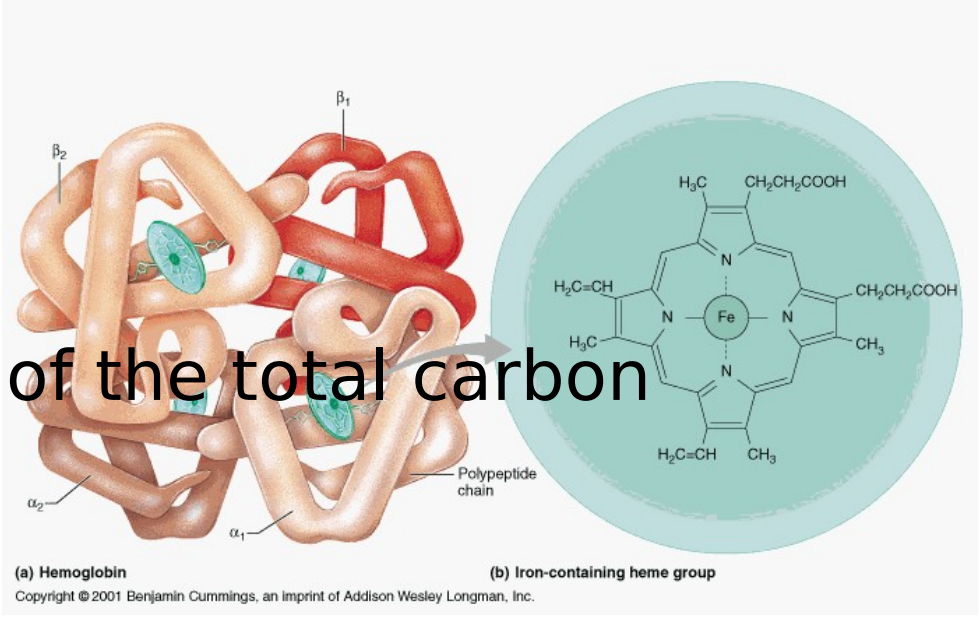
RED BLOOD CELLS (RBC): PHYSIOLOGY

- highly specialized for oxygen transport function
- generate ATPs anaerobically
- a biconcave disc has a much greater surface area for the diffusion of gas molecules



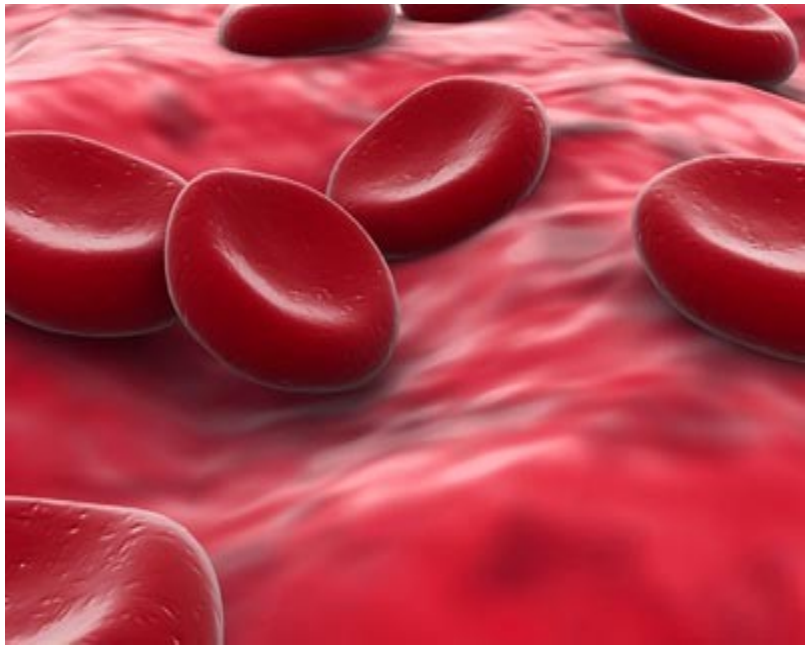
Red blood cells: PHYSIOLOGY

- transports about 23% of the total carbon dioxide



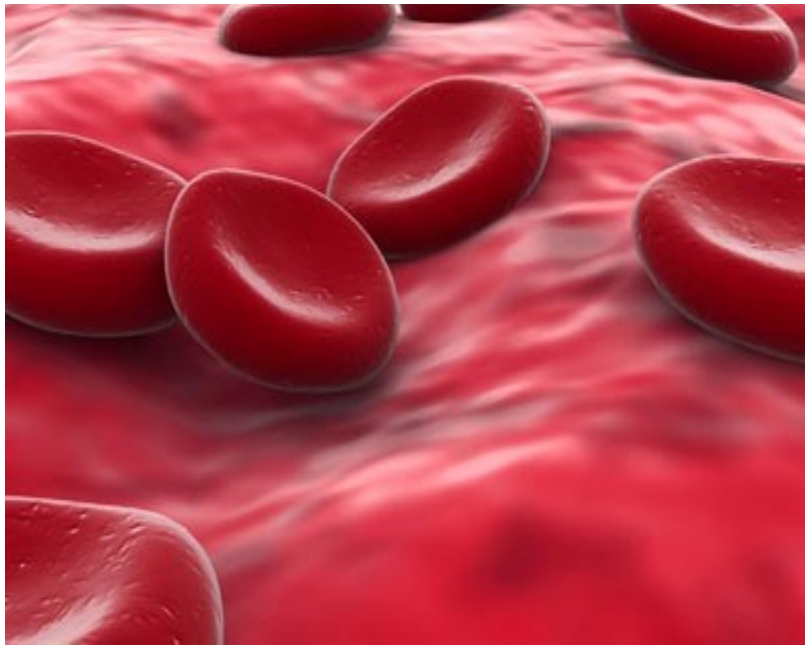
- plays a role in the regulation of blood flow and blood pressure
  - Nitric oxide (NO) hormone
    - produced by the endothelial cells that line blood vessels
    - causes vasodilation
    - improves blood flow and enhances oxygen delivery to cells

red blood cells: LIFE CYCLE



- life span is about 120 days
- plasma membrane becomes more fragile with age
- ruptured red blood cells are removed from circulation and destroyed by fixed phagocytic macrophages in the spleen and liver

red blood cells: LIFE CYCLE



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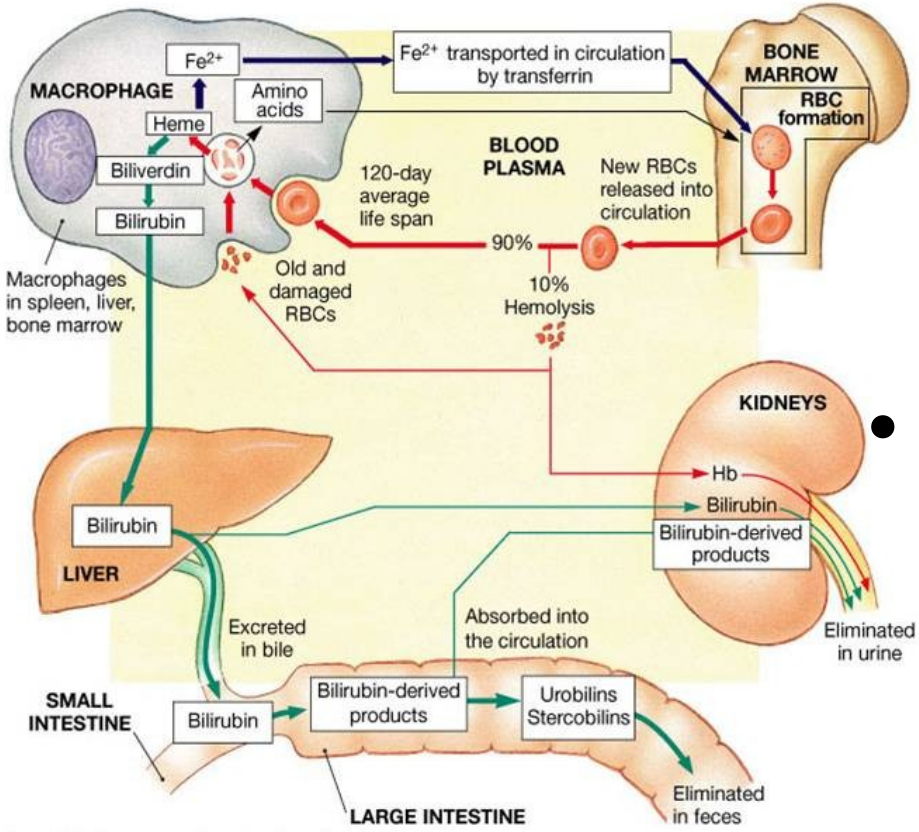
red blood cells: LIFE CYCLE



- macrophages in the spleen, liver, or red bone marrow phagocytize ruptured and worn-out red blood cells
- globin and heme portions of hemoglobin are split apart
- globin is broken down into amino acids

red blood cells: LIFE CYCLE

- iron is removed from the heme portion in the form of Fe^{3+}, which associates with the plasma protein transferrin (*a transporter* for Fe^{3+} in the bloodstream)

- In muscle fibers, liver cells, and macrophages of the spleen and liver, Fe^{3+} detaches from transferrin and attaches to an iron-storage

red blood cells: LIFE CYCLE

- upon release from a storage site or absorption from the gastrointestinal tract, Fe^{3+} reattaches to transferrin

red blood cells: LIFE CYCLE

- the Fe^{3+}–transferrin complex is then carried to red bone marrow, where RBC precursor cells take it up through receptor-mediated endocytosis for use in hemoglobin synthesis. Iron is needed for the heme portion of the hemoglobin molecule, and amino acids are needed for the globin portion. Vitamin B12 is also needed for the synthesis of hemoglobin

red blood cells: LIFE CYCLE

- erythropoiesis in red bone marrow results in the production of red blood cells, which enter the circulation

- when iron is removed from heme, the non-iron portion of heme is converted to biliverdin (a green pigment), and then into bilirubin (a yellow orange pigment)

- bilirubin enters the blood and is transported to the liver

red blood cells: LIFE CYCLE

- within the liver, bilirubin is released by liver cells into bile, which passes into the small intestine and then into the large intestine

- in the large intestine, bacteria convert bilirubin into urobilinogen

- some urobilinogen is absorbed back into the blood, converted to urobilin (a yellow pigment) called

red blood cells: LIFE CYCLE

- most urobilinogen is eliminated in feces in the form of stercobilin (a brown pigment), which gives feces its characteristic color

Sources of Iron

- DRIED HERBS
  - Thyme
  - Parsley
  - Spearmint
  - Black pepper
  - Oregano
  - Bay leaf
  - Basil
  - ground Tumeric
  - Anise seed
  - Rosemary

Sources of Iron

- pure cocoa powder and dark chocolate
- roated pumpkin and squash seed
- sesami butter and seeds
- sundried tomatoes
- sunflower seed

Sources of Iron

- kidney beans
- soybeans
- lentils
- black beans
- black-eyed beans
- molasses

Sources of Iron

- tofu
- spinach
- raisins
- whole wheat bread

High Risk Groups for an Iron Deficiency

- Menstruating Women
  - blood loss during menstruation women of child bearing age
  - the greater the blood loss the greater the risk

- Individuals with Kidney Failure
  - inability of the kidney to create adequate amounts of the hormone erythropoietin

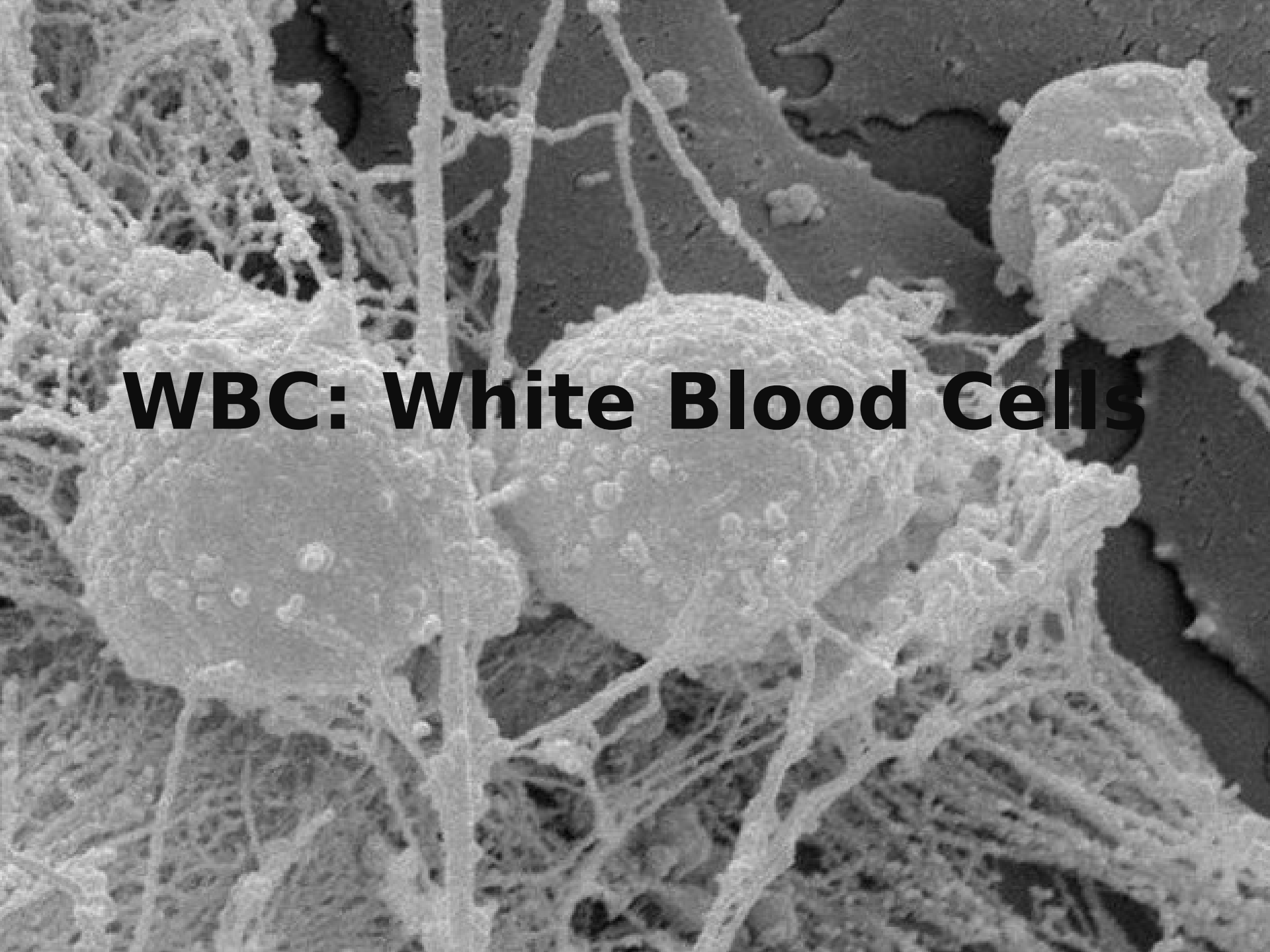
High Risk Groups for an Iron Deficiency

- Pregnant and lactating women
  - a developing fetus requires a high amount of iron
  - there is a high amount of iron lost through breast milk after birth

- Older infants and toddlers People with low levels of Vitamin A
  - Vitamin A greatly helps move iron from storage in the body and without adequate amounts of vitamin A the body cannot regulate iron properly

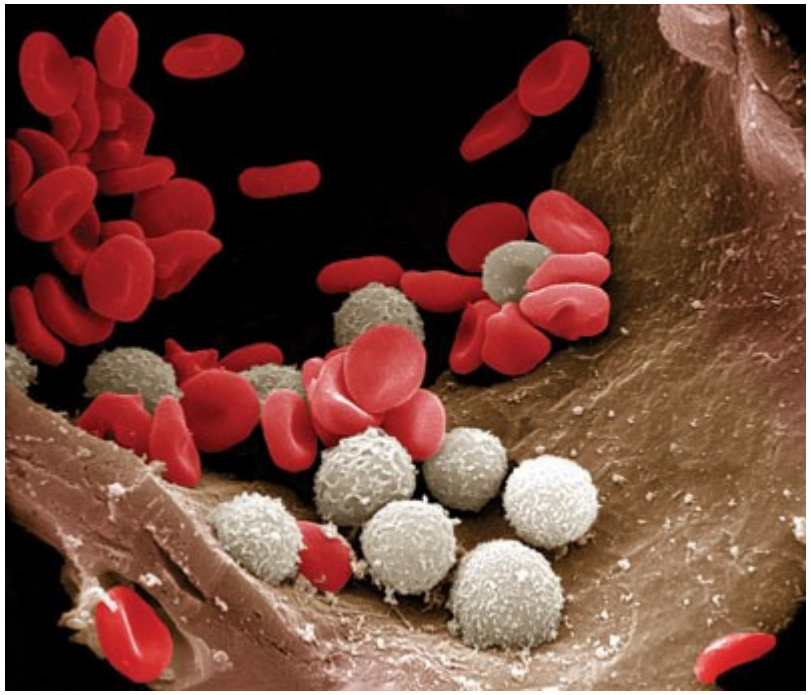
High Risk Groups for an Iron Deficiency

- People with gastrointestinal disorders
  - diarrhea, ulcers, and other gastrointestinal disorders and diseases can lead to an inadequate iron



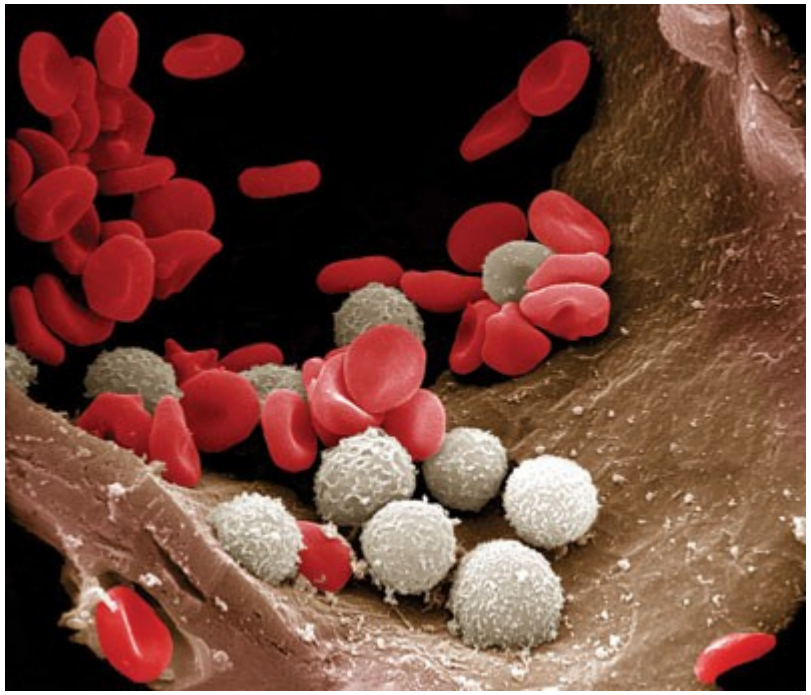
WBC: White Blood Cells

BLOOD CELLS (WBC)



- leukocytes
- have nuclei
- do not contain hemoglobin
- 5000–10,000 cells per µl
- RBC vs. WBC
  - 700:1

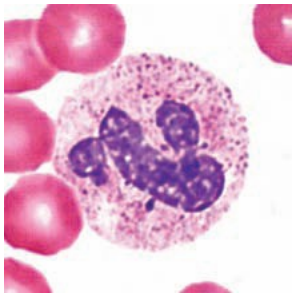
cells: GENERAL TYPES

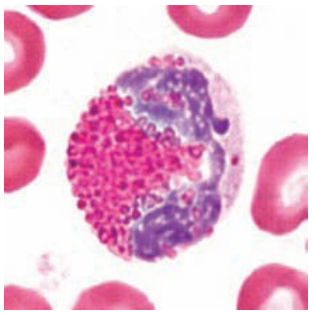


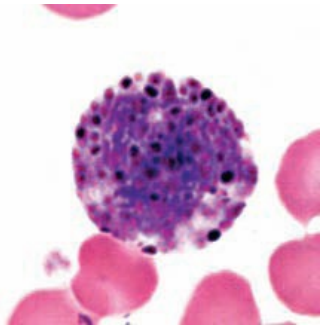
- depending on whether they contain cytoplasmic granules (vesicles) that are made visible by staining when viewed through a light microscope

- granular leukocytes

White blood cells: GRANULAR LEUKOCYTES

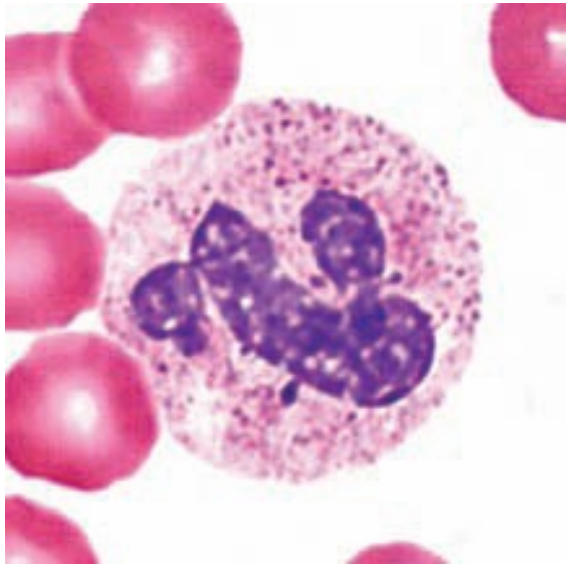






- contain cytoplasmic granules (vesicles)
- neutrophils
- eosinophils
- basophils

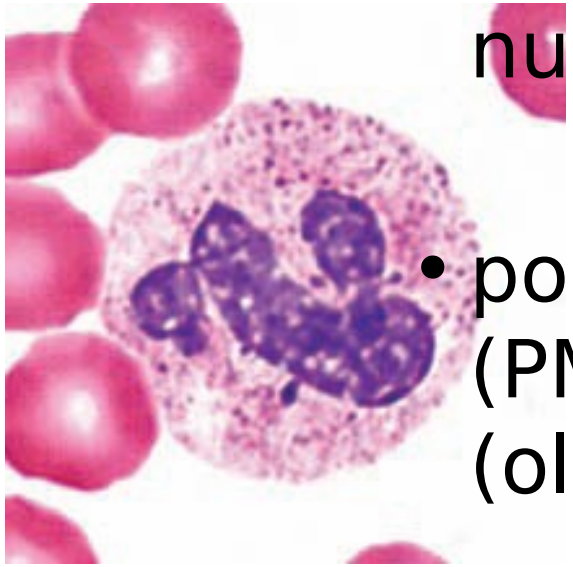
White blood cells: GRANULAR LEUKOCYTES



- Neutrophils
  - the granules are smaller and are evenly distributed
  - granules are pale lilac in color
  - the nucleus has two to five lobes
    - connected by very thin

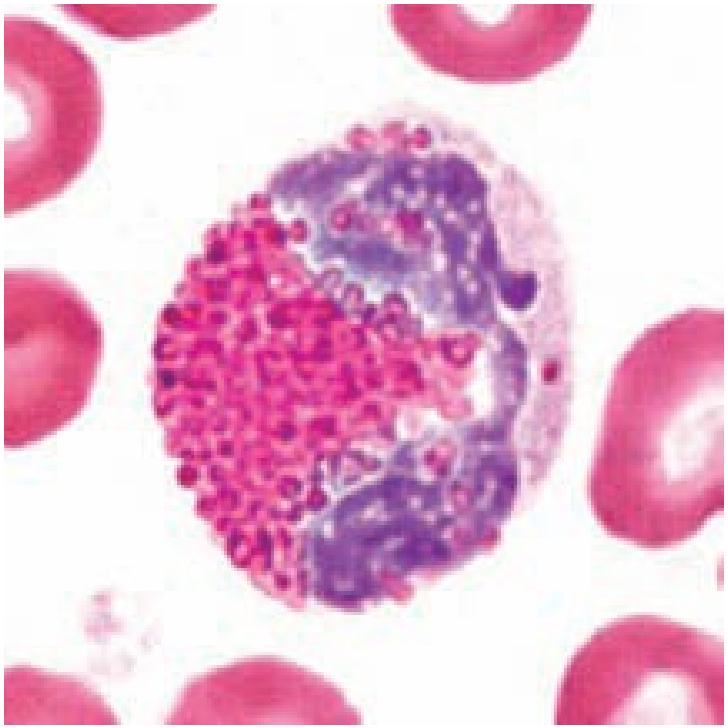
White blood cells: GRANULAR LEUKOCYTES

- neutrophils
  - as the cells age, the number of nuclear lobes increases



  - polymorphonuclear leukocytes (PMNs), polymorphs, or “polys” (old neutrophils)
  - bands (younger neutrophils)
    - their nucleus is more rod-

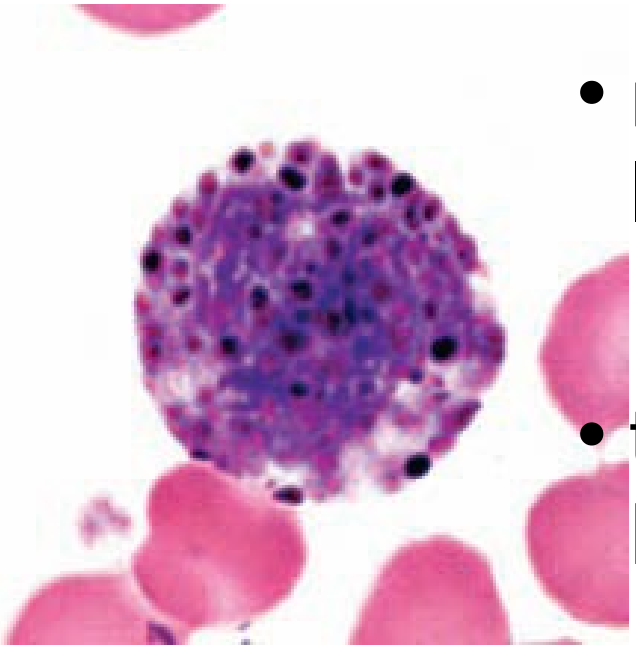
White blood cells: GRANULAR LEUKOCYTES



- eosinophils
  - large eosin-loving, uniformsized granules
  - they stain red-orange with acidic dyes
  - the granules usually do not cover or obscure the nucleus
  - most often has two lobes connected by a thick strand of chromatin

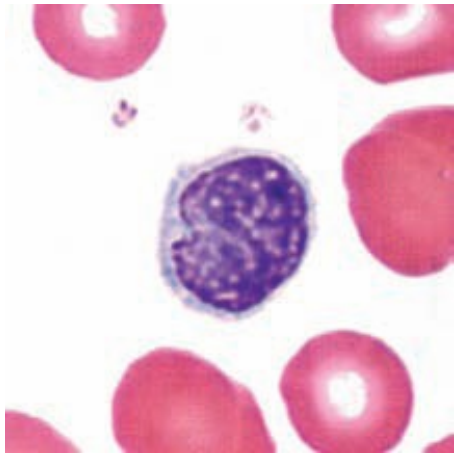
White blood cells: GRANULAR LEUKOCYTES

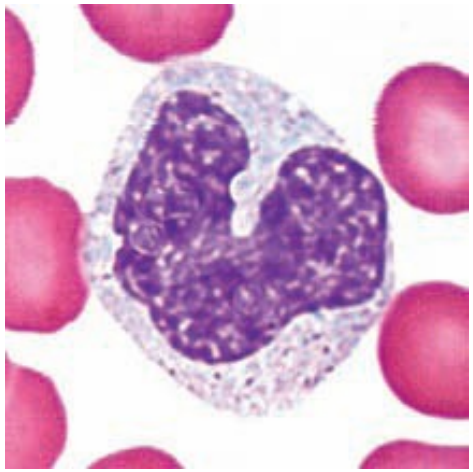
- basophils



- round, variable-sized basic-loving granules
- they stain blue-purple with basic dyes
- the granules commonly obscure the nucleus, which has two lobes

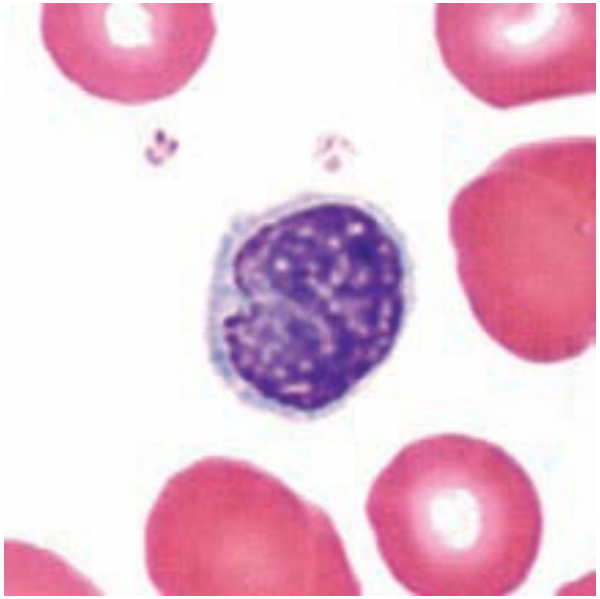
White blood cells:
AGRANULAR LEUKOCYTES





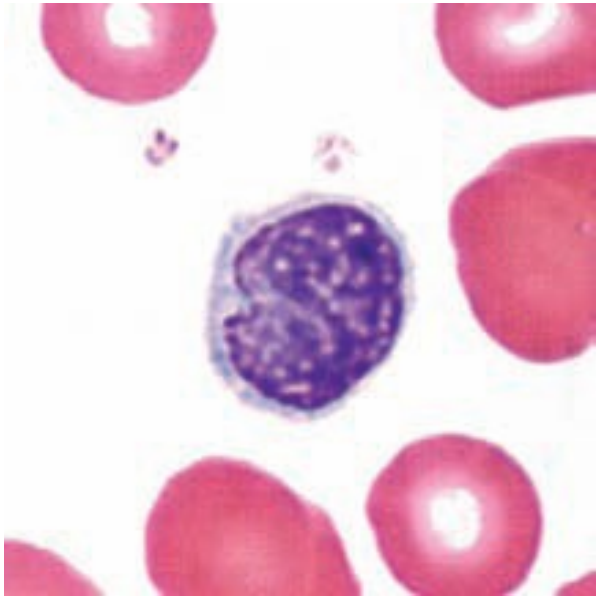
- contain cytoplasmic granules (vesicles) but not visible under the light microscope
- granules have small size and poor staining qualities
- lymphocytes

White blood cells:
AGRANULAR LEUKOCYTES



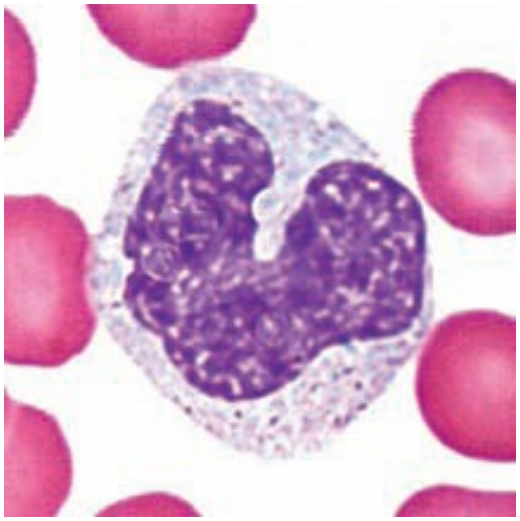
- Lymphocytes
  - nucleus is round or slightly indented and stains darkly
  - cytoplasm stains sky blue and forms a rim around the nucleus
  - small as 6–9 µm in

White blood cells:
AGRANULAR LEUKOCYTES



- Lymphocytes
  - T lymphocytes (T cells)
  - B lymphocytes (B cells)
  - natural killer (NK) cells

White blood cells:
AGRANULAR LEUKOCYTES

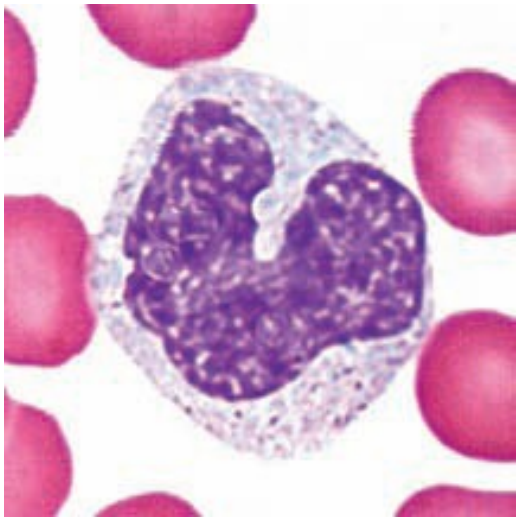


- Monocytes
  - 12–20µm in diameter
  - nucleus is usually kidney shaped or horseshoe shaped
  - cytoplasm is blue-gray and has a foamy appearance
  - azurophilic granules
    - lysosomes

White blood cells:

AGRANULAR LEUKOCYTES

- Monocytes

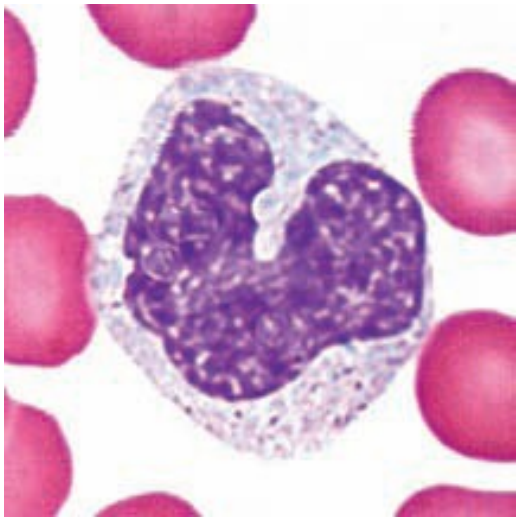


- transported from the blood into the tissues, where they enlarge and differentiate into **MACROPHAGES**
  - **fixed macrophages**
  - **wandering macrophages**

White blood cells:

AGRANULAR LEUKOCYTES

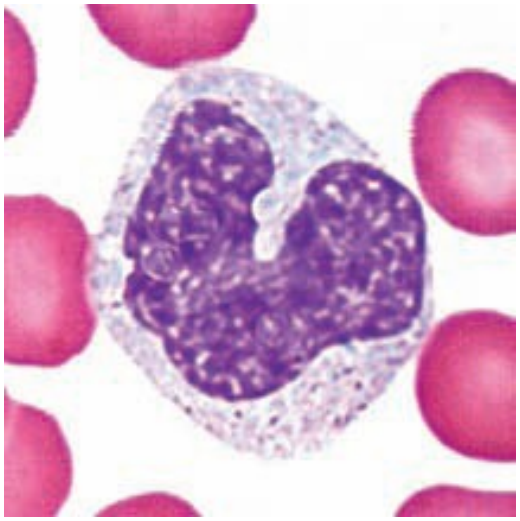
- MACROPHAGES
  - **fixed macrophages**



- they reside in a particular tissue
- alveolar macrophages in the lungs
- macrophages in the spleen
- stellate reticuloendothelial (Kupffer) cells in the liver

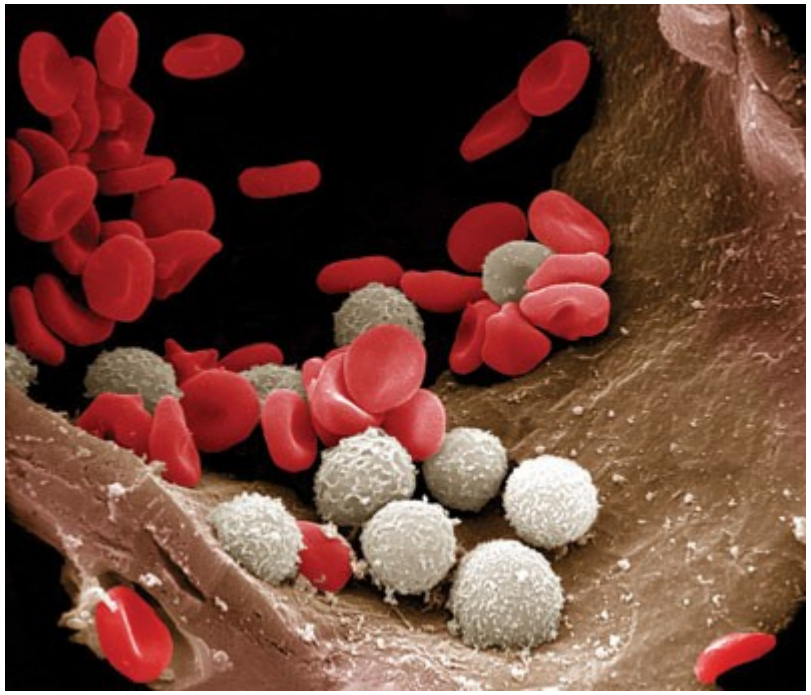
White blood cells:
AGRANULAR
LEUKOCYTES

- MACROPHAGES



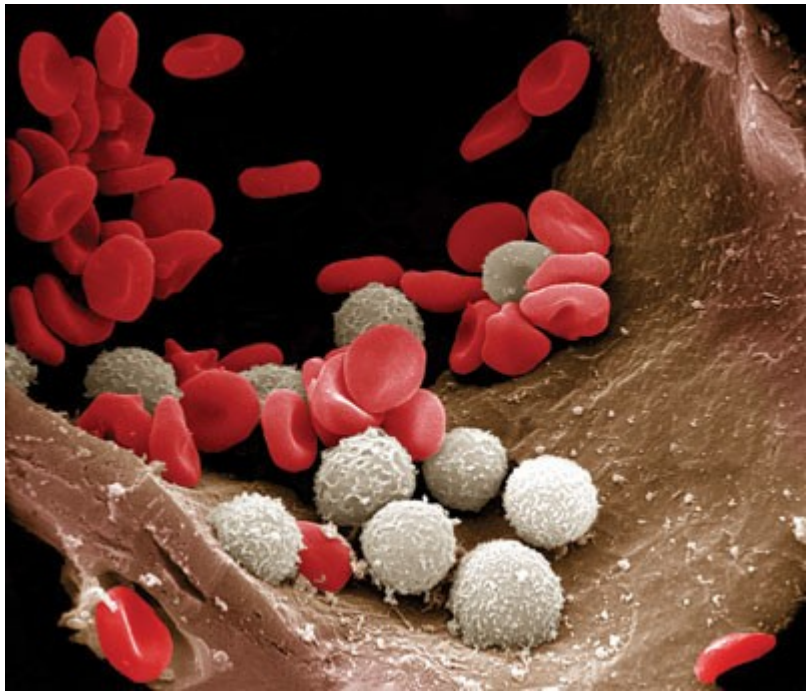
- **wandering macrophages**
  - roam the tissues and gather at sites of infection or inflammation

BLOOD CELLS (WBC)



- **major histocompatibility (MHC) antigens**
  - proteins protruding from their plasma membrane into the extracellular fluid
  - these “cell identity markers” are unique for each person

white blood cells: FUNCTIONS



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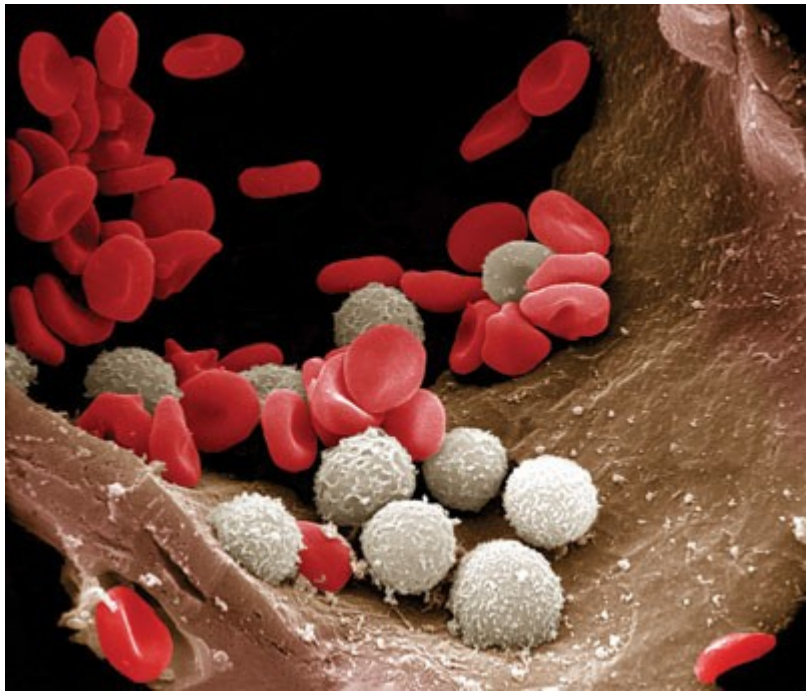
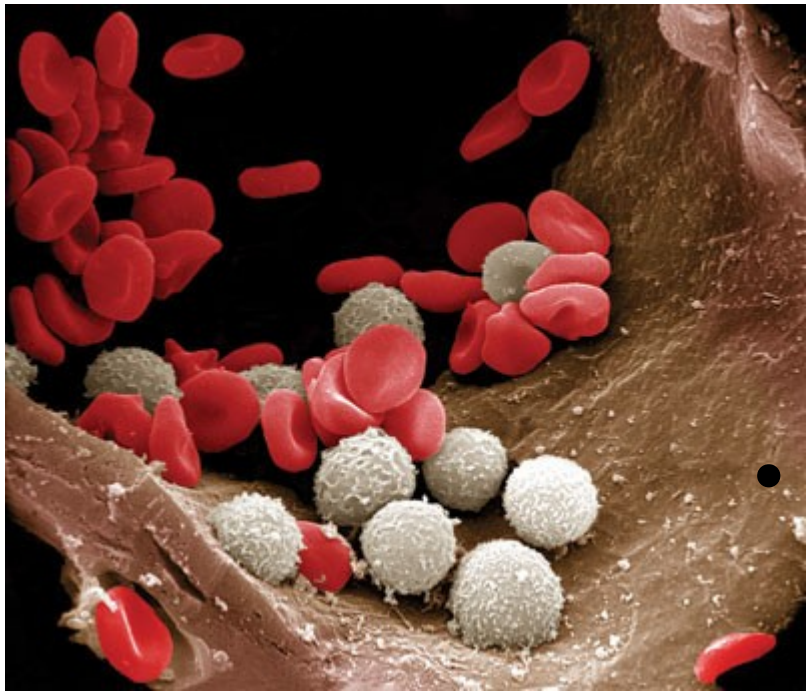


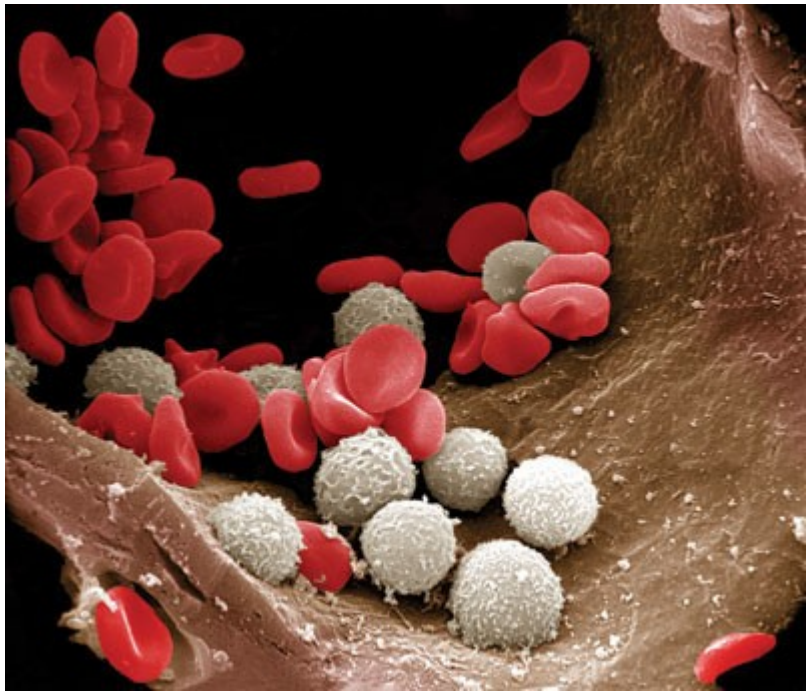
- Neutrophils and macrophages
  - they can ingest bacteria and dispose of dead matter (phagocytosis)
  - Lysozyme
  - strong oxidants
    - Superoxide anion (O_2^-)

white blood cells: FUNCTIONS



- monocytes
  - take longer to reach a site of infection but they arrive in larger numbers and destroy more microbes
- basophils
  - contain heparin, histamine, and Serotonin that intensify the inflammatory reaction and in

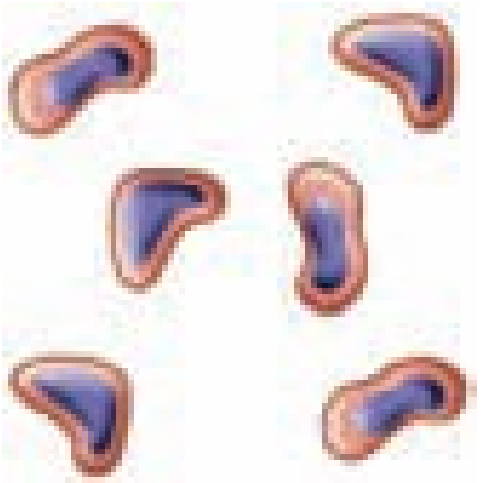
white blood cells: FUNCTIONS



- eosinophils
  - phagocytize antigen–antibody complexes and are effective against certain parasitic worms
- lymphocytes
  - the major soldiers

PLATELETS: THROMOBOCYTES

platelets



- between 150,000 and 400,000 platelets are present in each L of blood
- disc-shaped, 2–4μm in diameter, and has many vesicles but no nucleus
- short life span, normally just 5 to 9 days
- help stop blood loss from damaged blood vessels by forming a platelet plug

BLOOD TYPE AND GROUP


TransClone
ANTI-A 26A2
TransClone
ANTI-B 95.3

Functions of Blood

- Transportation
  - transports oxygen from the lungs to the cells of the body
  - transports carbon dioxide from the body cells to the lungs for exhalation
  - carries nutrients from the gastrointestinal tract to body cells
  - carries hormones from endocrine glands to other body cells
  - transports heat and waste products to various organs for elimination from the body.

- Regulation
  - helps regulate pH through the use of buffers.
  - helps adjust body temperature through the heat absorbing and coolant properties of the water in blood plasma
  - its variable rate of flow through the skin, where excess heat can be lost from the blood to the environment.
  - blood osmotic pressure influences the water content of cells, mainly through interactions of dissolved

- Protection
  - protects against excessive loss from the cardiovascular system after an injury.
  - white blood cells protect against disease by carrying on phagocytosis
  - several types of blood proteins, including antibodies, interferons, and complement, help protect against disease in a variety of ways.